Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_

**Unit 8, Part 1 Notes: The Origin and History of Life**

Pre-AP Biology, Mrs. Krouse

**1. Theories of the Origin of Life**

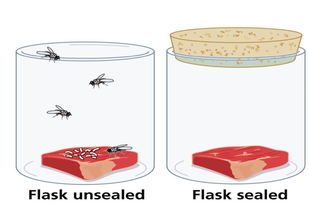
1. During the Dark Ages (6th-10th centuries, according to some sources), scholars devised the first theory explaining the origin of living things (i.e., how living things are created). This theory was called **spontaneous generation**, and it stated that living things arise from non-living matter. The idea of spontaneous generation was based on observations that living things seemed to suddenly appear on non-living things. For example, during this time, people noticed that rats (living) seemed to appear on dirty clothes (non-living), and frogs (living) seemed to appear in mud (non-living). They also noticed that maggots, which are baby flies, seemed to appear on rotting meat. Meat was once muscle tissue in a living organism (ex: pig or cow), but it is no longer considered alive once it is taken out of the organism.

***Practice Question 1*:** Look up the meaning of the terms “spontaneous” and “generation” on your phone or in a dictionary (these do still exist).How do the meanings of these terms relate to the theory of spontaneous generation?

1. During the Renaissance (specifically the year 1668), an Italian doctor named **Francesco Redi** proposed an alternate theory to spontaneous generation. His theory was called **biogenesis**, and it stated that living things come from other living things. In other words, baby organisms have to come from parent organisms!

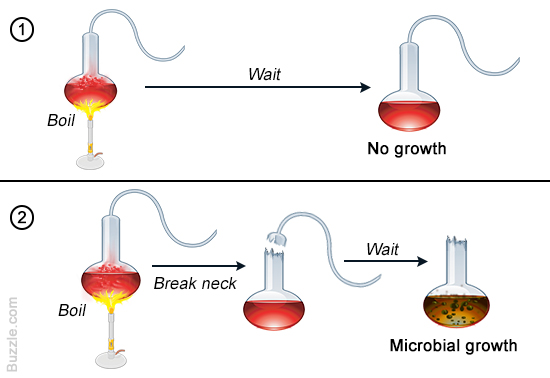
***Practice Question 2:*** Look up the meaning of the prefix “bio” and the term “genesis” on your phone or in a dictionary. How do the meanings of these prefixes/terms relate to the theory of biogenesis?

1. Redi designed an experiment to test his theory. He hypothesized that maggots (baby flies) come from eggs laid by parent flies, not from non-living rotting meat. He set up two jars that contained rotting meat. He placed a lid on the first jar and left the second jar open. He used the lid on the first jar to prevent adult flies from flying into the jar, landing on the meat, and laying eggs.
2. After letting the jars sit for a few days, he found maggots in the second jar, but not the first jar.



***Practice Question 3:*** Did the results of Redi’s experiment support the theory of spontaneous generation or biogenesis? Explain your answer, and make sure to directly refer to the results of the experiment.

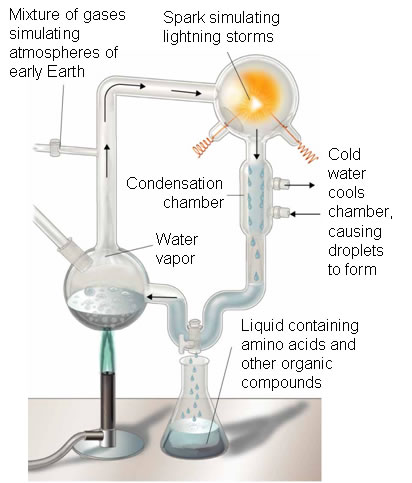
1. In 1862, another scientist named **Louis Pasteur** designed an alternate experiment to test the theory of biogenesis. He noticed that large groups of bacteria (living) tended to appear in chicken broth (non-living). He hypothesized that these large groups of bacteria were created by reproduction of bacteria from the air that contaminated the broth. In other words, he did not believe that the bacteria were created from the non-living broth itself. In his experiment, Pasteur set up two flasks that contained broth. He boiled the broth to kill off any existing bacteria. One of the flasks had an open neck that could allow bacteria from the air to contaminate the broth. The other flask had a “swan neck,” which is shaped in such a way that it does not allow bacteria from the air to enter the flask and contaminate the broth. We can also call a “swan-necked” flask a “close-necked” flask.
2. Pasteur allowed the broth in both flasks to sit for a full year (WOW). At the end of the year, he found bacteria in the open-necked flask but not the swan-necked flask.



***Practice Question 4:*** Did the results of Pasteur’s experiment support the theory of spontaneous generation or biogenesis? Explain your answer, and make sure to directly refer to the results of the experiment.

1. The Earth formed 4.6 billion years ago. However, the first living things (which were unicellular organisms similar to modern bacteria) are dated to around 3.5 billion years ago. The first living things arose shortly after Earth’s surface cooled enough for liquid water to form oceans around 3.8 billion years ago.
2. Two scientists, **Stanley Miller and Harold Urey** hypothesized that the first small, **organic** (carbon-containing) molecules like amino acids (the building blocks of proteins) could be formed from a reaction between the following components…

* Gases and particles found in early Earth’s atmosphere such as volcanic ash, CO2 (carbon dioxide), SO2 (sulfur dioxide), methane, and ammonia (Note: There was very little, if any, oxygen gas in early Earth’s atmosphere.)
* Energy from lightning storms, which were common on early Earth

1. Miller and Urey argued that lightning provided the energy to rearrange the atoms in the gases and particles to create simple organic molecules like amino acids. They set up an experiment to replicate this process. In their experiment, they heated water so that it became water vapor (a gas) and mixed it with gases from early Earth’s atmosphere. They then exposed the mixture to an electrical spark, which simulated a lightning storm. After this, they cooled down the mixture so that it converted back into a liquid from a gas.
2. In the liquid, they found amino acids and other small organic compounds (ex: cytosine and uracil, two nitrogenous bases found in nucleic acids like DNA and/or RNA).
3. Miller and Urey’s results indicated that simple organic compounds (ex: amino acids) found today in living cells could have arisen from the conditions present on a primitive Earth.

***Practice Question 5:*** Miller and Urey conducted their experiment fully enclosed inside a glass apparatus (see image to the right). Why did they do this?

1. Once simple organic molecules were created, they joined together to form larger molecules called **macromolecules** in a process called **polymerization.**

***Practice Question 6:*** For each of the four macromolecules and their **polymers** listed below, identify the names of their building block molecules (**monomers**).

|  |  |  |
| --- | --- | --- |
| **Macromolecule** | **Polymer** | **Monomer** |
| Carbohydrate | Polysaccharide |  |
| Lipid | Examples: Fats (triglycerides, Oils, Waxes, Phospholipids |  |
| Protein | Polypeptide |  |
| Nucleic Acid | Examples: DNA and RNA |  |

***Practice Question 7:*** Using your Unit 2 (Biochemistry), Part 3 (Macromolecules) Notes or your fantastic memory, define the following terms…

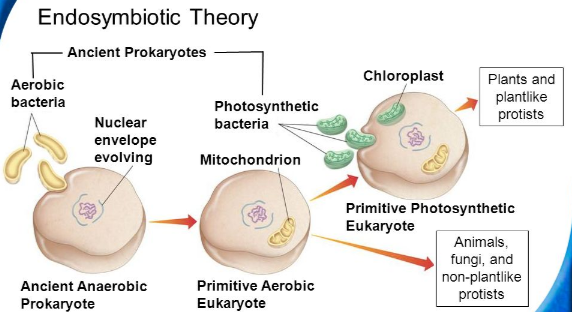
1. Monomer:
2. Polymer:
3. Polymerization:
4. Dehydration Synthesis:
5. Hydrolysis:
6. After macromolecules were created through polymerization, the first biological **membranes** were created from **phospholipids** arranged in a **bilayer** (double layer). They formed sphere-shaped structures called **protocells or microspheres**. The inside of a protocell contained fluid with other macromolecules like proteins and sugars (carbohydrates).

***Practice Question 8:*** Using your Unit 3 (Cell Structure and Transport), Part 4 (Cell Membrane and Transport) Notes or your fantastic memory…

1. Draw a phospholipid. Label the hydrophilic head and hydrophobic tails.
2. What does hydrophilic mean?
3. What does hydrophobic mean?
4. Why do phospholipids arrange themselves in a bilayer (double layer)? Draw this phospholipid bilayer in the space below.
5. For these early cells to reproduce and form new cells, they needed a genetic molecule that could be replicated and passed down to offspring cells. Scientists believe that RNA (not DNA) was the first nucleic acid to be used as genetic material because certain types of RNA can self-replicate, meaning they can make copies of themselves without the use of helper enzymes like helicase, DNA polymerase, ligase, etc.
6. Eventually DNA became the genetic molecule in all living things because it is a more stable molecule than RNA and is therefore less likely to be damaged.
7. Notice that the first living cells were not created from other living cells. They were created from a series of lucky chemical reactions that resulted in the formation of small organic molecules, large organic molecules, and eventually the aggregation of phospholipids to form membranes.

**2. The History of Life**

1. The first true organisms were **unicellular** (single-celled) and similar to a type of modern bacteria called archaebacteria. They were **heterotrophic**, which means they consumed other organisms to obtain glucose. They were also **prokaryotic**, meaning they had no nucleus or membrane-bound organelles.
2. Certain types of bacteria called **cyanobacteria** (also called **blue-green algae**) were the first organisms to use the process of **photosynthesis** to make their own glucose from carbon dioxide using the energy in sunlight. As a product of photosynthesis, they released oxygen gas. This put more oxygen gas into the atmosphere, making it possible for aerobic (oxygen-requiring) organisms to arise.
3. The ancestor of all **eukaryotic** cells (i.e. cells containing a nucleus and membrane-bound organelles) arose when prokaryotic cells began forming a system of internal membranes. This process resulted in the nuclear membrane surrounding the DNA and the creation of organelles like the ER and Golgi that are made out of membrane.
4. This ancestral eukaryotic cell became even more complex through a process called **endosymbiosis**. During endosymbiosis, this ancestral eukaryotic cell engulfed or “swallowed” a small prokaryotic cell. This small prokaryotic cell began performing a particular function for the larger cell and lost its ability to live outside the larger cell.
5. For example, mitochondria arose through endosymbiosis. They were once free-living bacteria that were able to convert energy from glucose into ATP in the presence of oxygen through cellular respiration.
6. Chloroplasts also arose through endosymbiosis (after mitochondria). Chloroplasts were once free-living photosynthetic bacteria.



1. Evidence to suggest that chloroplasts and mitochondria were once free-living bacteria (prokaryotic cells) includes…

* The fact that chloroplasts and mitochondria have a double membrane. (As free-living bacteria, they had one membrane. They gained another membrane as they were engulfed by the ancestral eukaryotic cell.)
* The fact that chloroplasts and mitochondria have their own DNA.
* The fact that chloroplasts and mitochondria have their own ribosomes.
* The fact that mitochondria can replicate (make copies of themselves) using a process similar to binary fission, which modern bacteria use to divide and reproduce.

***Practice Question 9:***  Look up the meaning of the prefix “endo” and the term “symbiosis” on your phone or in a dictionary. How do the meanings of these prefixes/terms relate to the theory of endosymbiosis?

1. Later, the first **multicellular** organisms evolved. Multicellular organisms are placed in three groups—animals, plants, and fungi. These organisms have **specialized cells** to perform particular functions. For example, we have nerve cells for sending signals and muscle cells for movement.
2. The first animals were aquatic invertebrates. In other words, they lived in water and did not have a backbone (ex: sponges, jellyfish, mollusks, etc.) Eventually, some of these animals evolved into terrestrial (i.e., land-living) groups, and some evolved backbones.
3. The five groups of vertebrates (i.e., organisms with a backbone) are fish, amphibians, reptiles, birds, and mammals.

***Practice Question 10:*** List the descriptions of events in the history of life and their corresponding pictures in the correct order.

|  |  |  |
| --- | --- | --- |
| **Step** | **Description** (write it out!) | **Picture** (write the letter of the correct picture) |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**Descriptions:**

* The first membranes and protocells evolved
* Multicellular organisms evolved with specialized cells to perform particular functions.
* The first organic molecules (ex: amino acids) were formed from components of the atmosphere and energy provided by lightning storms.
* Eukaryotic cells evolved through the process of endosymbiosis.
* Small organic molecules joined together in the process of polymerization to create macromolecules.

**Pictures:**

